Chapter 9
Planning and Design

9-1. General

Planning and design of a test fill program should be done with care to consider all the facets of the objectives of such a typically expensive investment. The proposed program should be thoroughly reviewed to assure that all procedures and tests are properly designated and planned in the order of the work. There is no better guidance available for laying out a program than to review those programs conducted by others, particularly for Corps of Engineer projects. This manual cannot substitute for the careful review of the details of procedures and findings to be found in the reports of test fills and test quarries for previous projects. As was suggested for a test quarry program, it is highly desirable that one individual be charged with responsibility in the field for conduct of the test fill and for dealings with the contractor.

9-2. Location of the Test Fill

The test fill should be located as near the test quarry or rock source as possible. This will obviously provide an economy of operation. If multiple test quarries are to be developed and multiple test fills associated with their yields, the siting considerations include the decision of multiple test-fill sites or a single larger site. The use of a stockpile between the test quarry and test fill operations depends upon the expected project construction operations. It has already been pointed out that stockpiling may produce changes in the rock gradations reaching the fill if for no other reason than the double-handling (loading and hauling). If stockpiling is not anticipated in the project construction, it should be avoided in the test-fill program if possible. If stockpiling is expected to be required in project construction, its effects should be assessed in the test-fill program. The test-fill site should be as level and of sufficient area to accommodate the test fill itself plus ample peripheral space to permit full equipment mobility. The site should be graded to provide good drainage.

9-3. Geometry

The geometry of the test fill configuration depends on the objectives and the variability and availability of the rock to be tested, not to mention constraints imposed by cost. In addition, there is considerable latitude deriving from individual preferences. It then becomes practical herein to only discuss test-fill geometry in the more general sense. The test fill should be of sufficient size to allow its performance to be as close to project fill behavior as possible. This means that the effects of scale should be minimized. Widths and lengths of individual test sections should be of sufficient magnitude so that settlement readings (discussed later) reflect densification from compactive effort alone and do not reflect lateral bulging of the fill. In most cases, a width of 10 to 15 m (about 30 to 50 ft) with a length at least equal to the width but 6 to 10 m (about 20 to 30 ft) longer, if feasible. The individual fill sections may abut each other longitudinally or be layed out in a parallel configuration with ramps on each end at slopes of 1 vertical on 5 horizontal or flatter to facilitate equipment entrance and exit. Maximum side slopes of 1 vertical to 1.5 horizontal are recommended. The ramps and side slopes may be constructed of quarry-run materials. Four or five layers (lifts) are usually sufficient to provide enough data to establish the compaction specifications for any one type of rock. Figures 9-1 through 9-10 provide examples of test fill geometries used for several Corps of Engineers dam projects.

9-4. Test Sections or Lanes

In the most ideal case allowing the easiest separation of variables, an individual test section or lane of a test fill should not contain different materials or be composed of different lift thicknesses, lifts compacted by different equipment, or a different number of passes applied to succeeding lifts. For example, suppose it is desired to evaluate 46- and 91-cm (18- and 36-in.) lifts. It would be more desirable to use two fill sections, one containing 46-cm (18-in.) lifts only and the other 91-cm (36-in.) lifts only, rather than one section containing lifts of both thicknesses (e.g., four to five 46-cm (18-in.) lifts over four or five 91-cm (36-in.) lifts). There have been cases where groups of different lift thickness were employed successfully in the same section with increasing lift thickness from bottom to top of the section as shown for Seven Oaks Dam in Figure 9-10. The use of the transition from thinner to thicker lifts from the base upward at least diminishes the effects of additional settlement of the lower lifts being included in with the measurements assessing the compaction applied to the upper, thicker ones. However, the Seven Oaks test program heavily relied on large-scale density tests taken in each lift after intermediate roller passes to assess compaction rather than strictly relying on surface settlement readings. In other cases of a single test section incorporating more than one lift thickness, measures were taken to eliminate the continued settlements of lower, thinner lifts from entering into the settlement readings for the upper lifts. This was

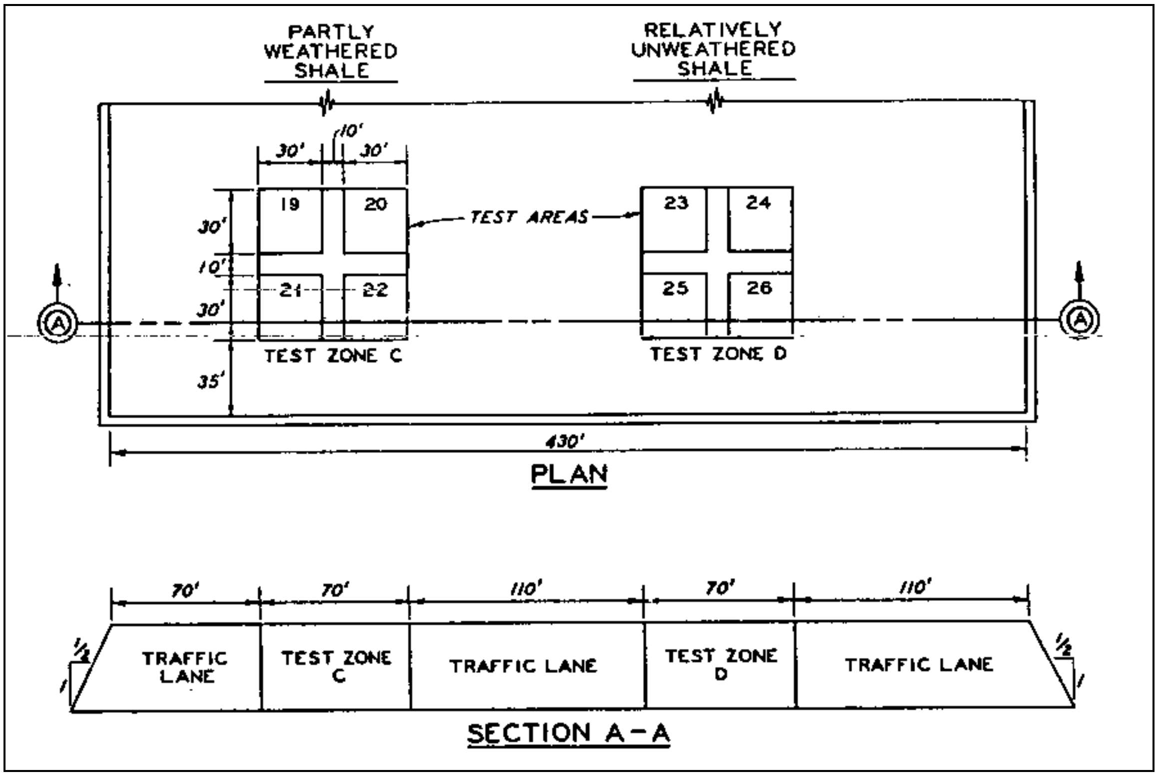


Figure 9-1. Beltzville Dam, plan and profile of the test fill

accomplished by either (a) rolling the last lower and thinner lift until no further settlement was seen before placing the upper, thicker lifts, or (b) installing settlement plates on the surface of the last, lower, thinner lift in order to subtract additional settlement from that observed for the upper lifts. The former method of “proof” rolling the lower lifts may completely alter that material with respect to its condition after a reasonable number of roller passes to be used in the project and compromise any observations from an inspection trench excavated after completion of the test fill. The use of settlement plates with stems up through additional thicker lifts poses troublesome obstructions in the placement and rolling of those lifts and may compromise their similarity to project conditions. In any case, enough lifts (four or five) of the same thickness must be used so that a good average settlement curve can be obtained for all like lifts in each zone.

9-5. Equipment

Generally, loading and hauling equipment should be used that will result in the most efficient operation and which is likely to be used for the project construction. Front-end loaders can be used to load the quarried rock into trucks for hauling to a processor or to the test fill. A loader is more maneuverable than a power shovel and less costly on small operations. Crawler tractors are the standard equipment for spreading materials to the desired loose lift thickness and in many cases of medium to soft rock have also proven capable of breaking down oversized pieces delivered to the test fill. In special cases (i.e., not very frequently), where crawler tractors have been seen to produce excessive degrading of the material, rubber-tried equipment has been used for spreading. For material which does not degrade through the compaction operation to the extent that it must be considered a soil, 9.1-Mg (10-ton) or 13.6-Mg (15-ton) vibratory rollers are the most common choices. For materials which are friable or weathered material which will degrade into an obvious soil during hauling, placement, and compaction, heavier vibratory, pneumatic, or tamping rollers may be required. For materials which arrive at the test fill or are broken down in spreading and compaction into a mixture of rock and soil, the means of determining whether they remain suitable for rockfill or must be treated as a soil in design, construction, and construction control will be addressed in Chapter 10.

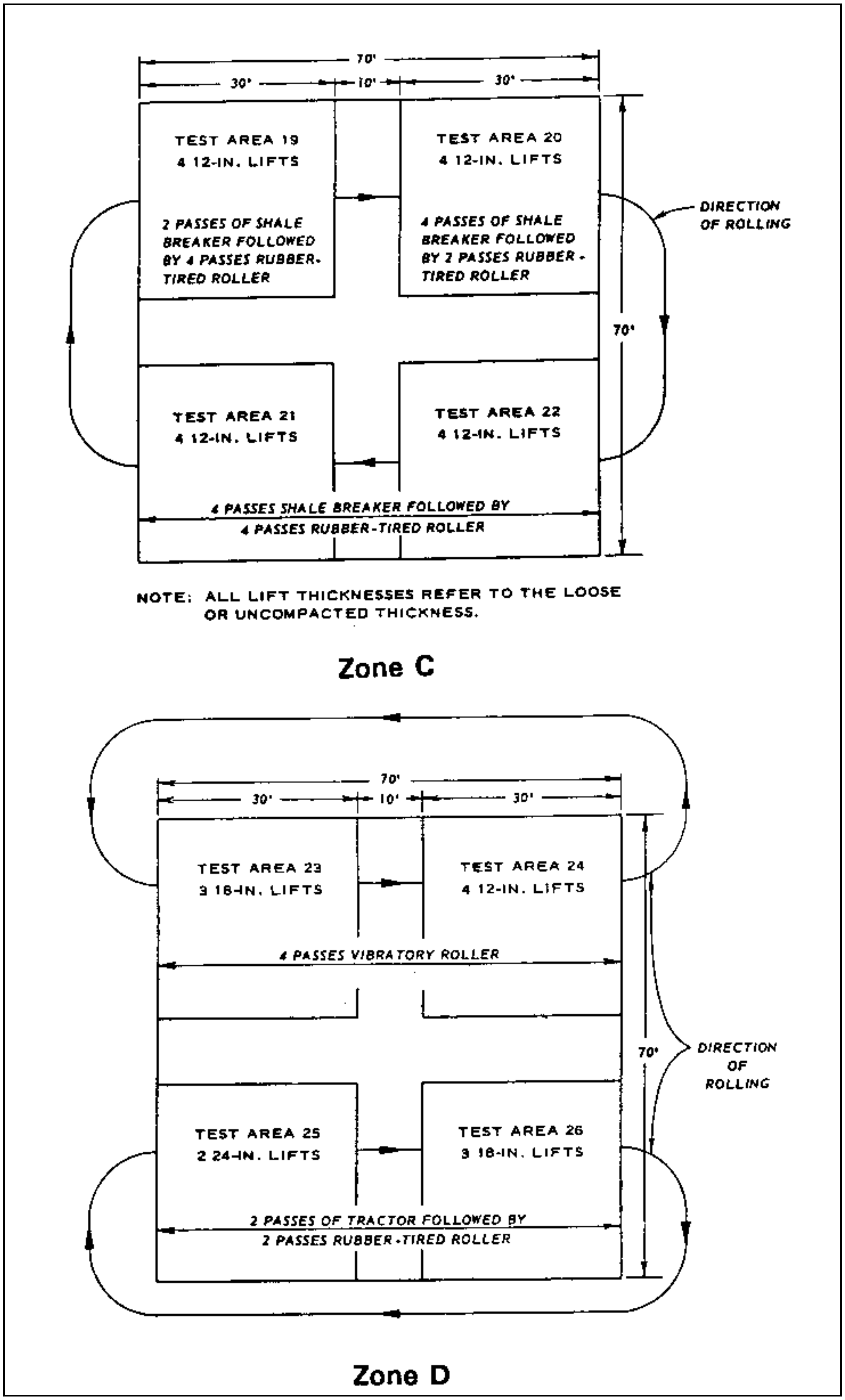


Figure 9-2. Beltzville Dam, plan view of the rolling pattern

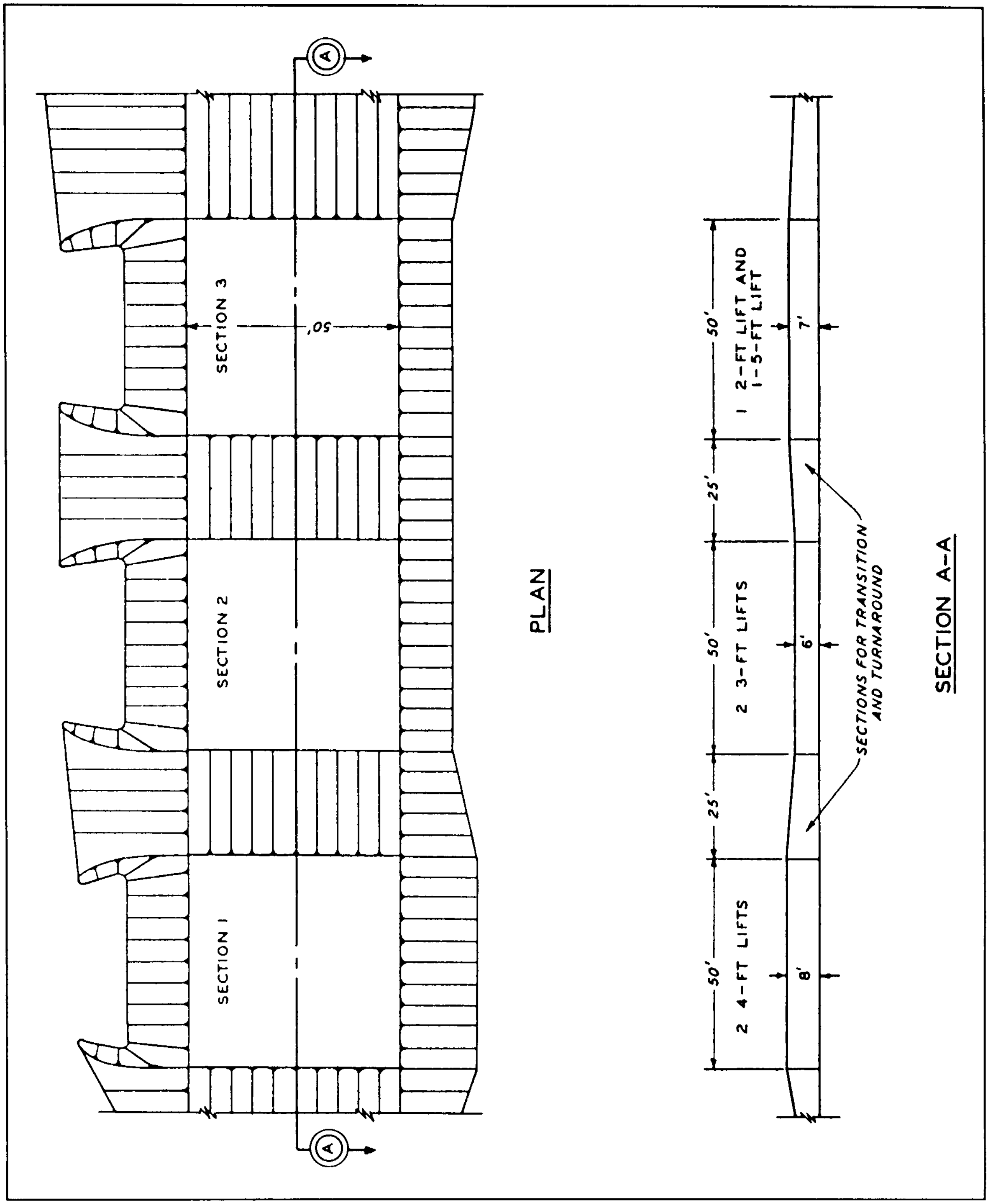


Figure 9-3. Laurel Dam, plan and profile of the test fill

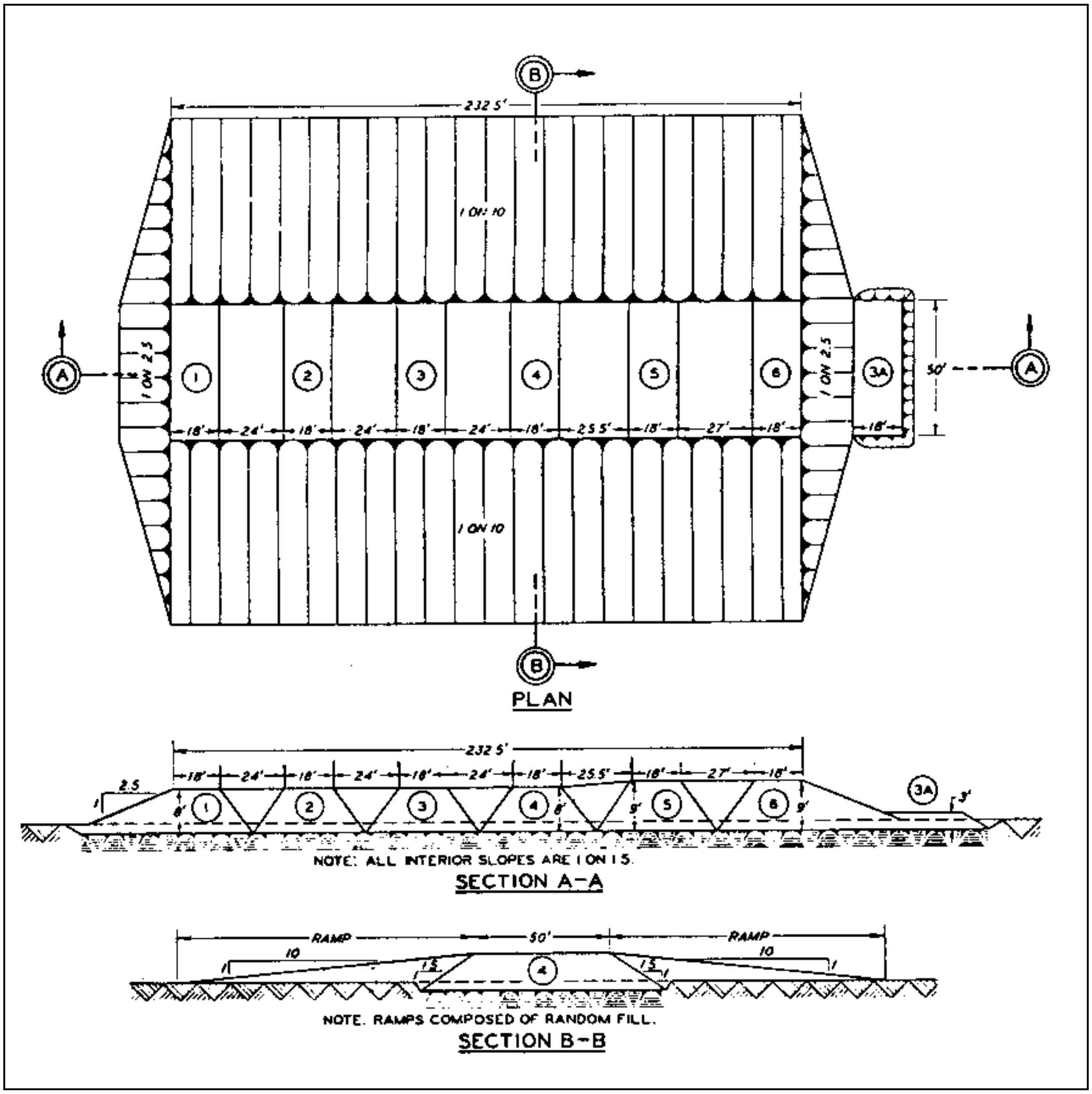


Figure 9-4. Gilham Dam, plan and profiles of the test fill

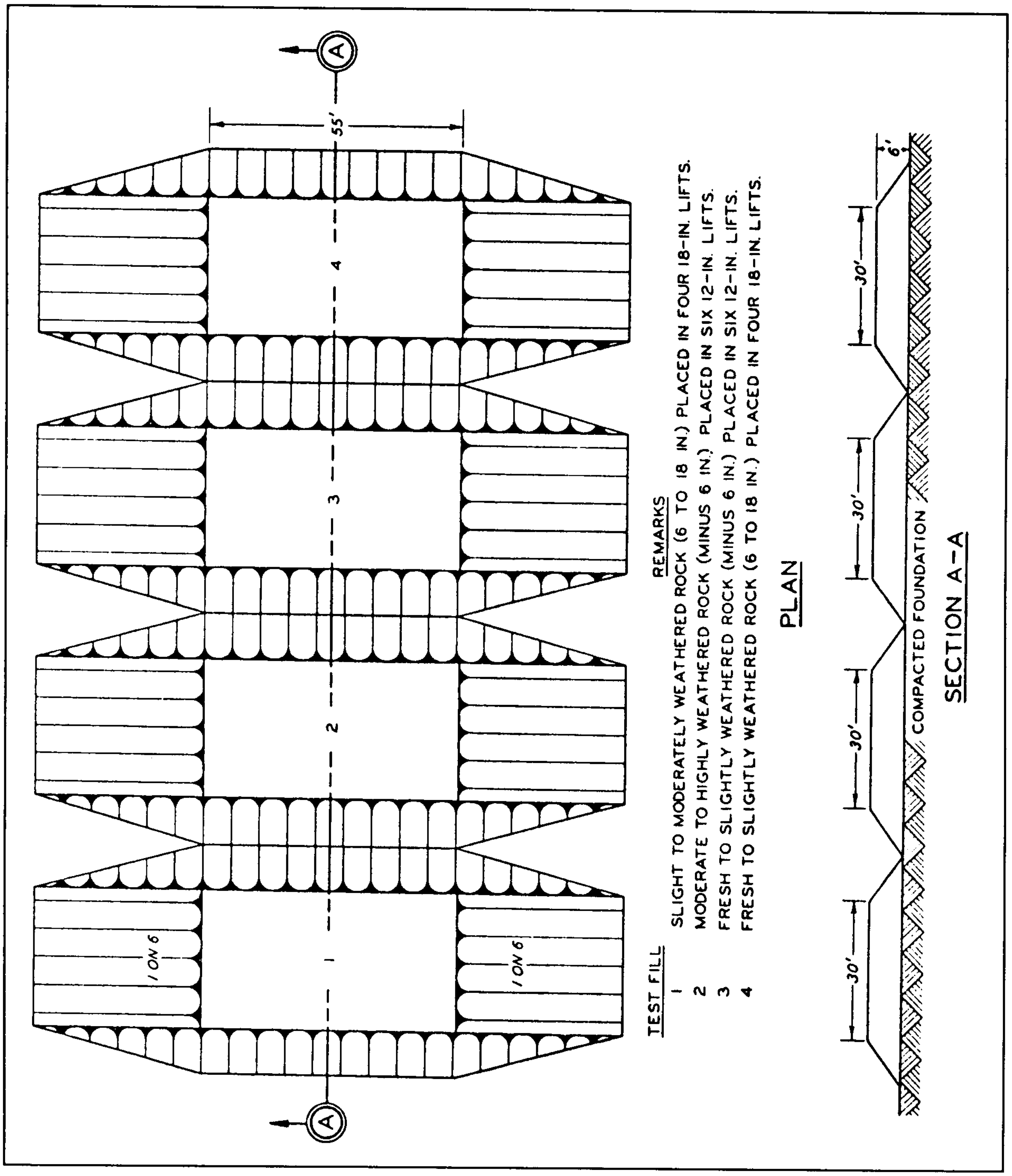
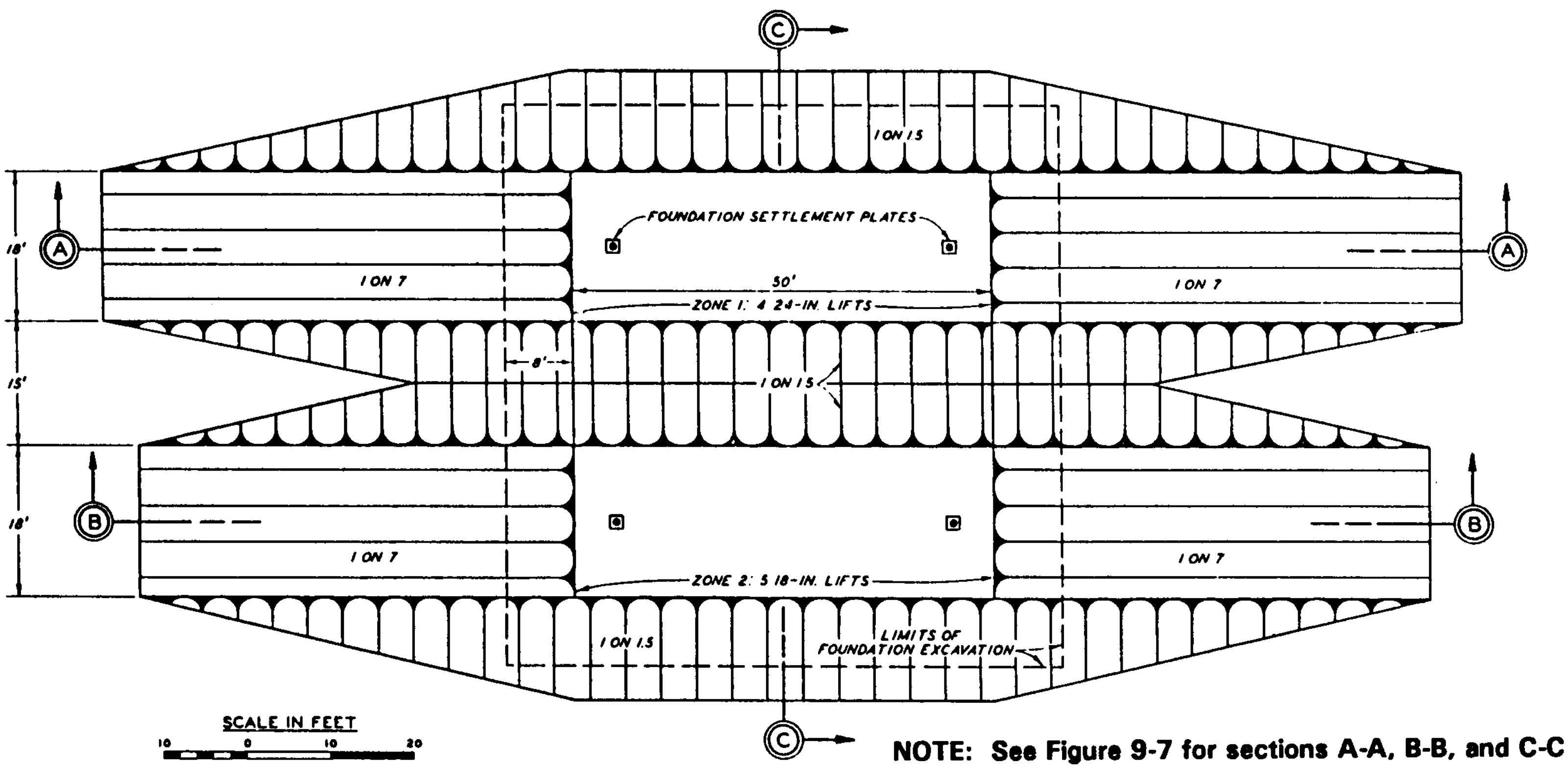


Figure 9-5. New Melones Dam, plan and profile of the test fill



NOTE: See Figure 9-7 for sections A-A, B-B, and C-C

Figure 9-6. Gathright Dam, plan view of the test fill

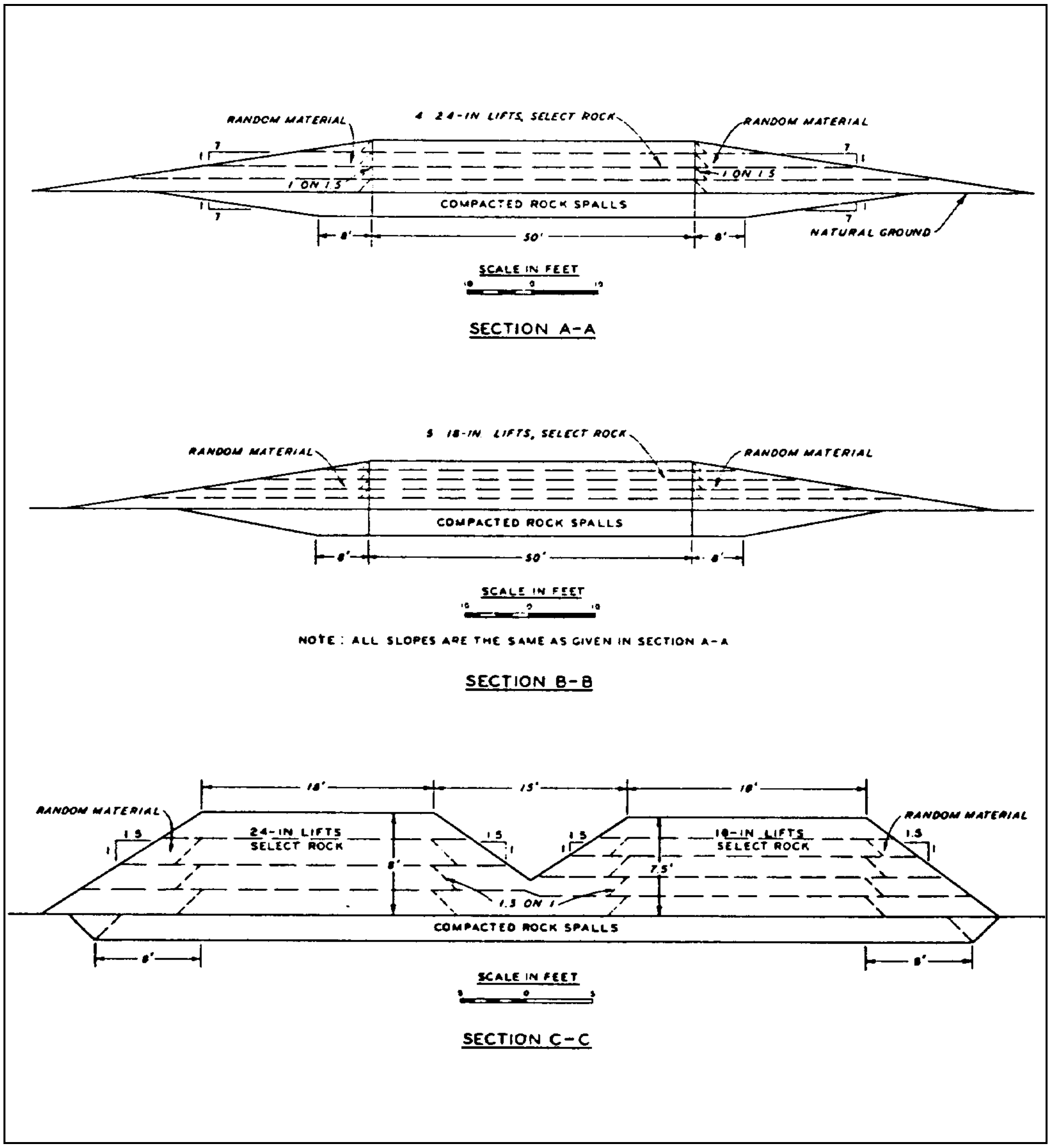


Figure 9-7. Gathright Dam, profiles of the test fills

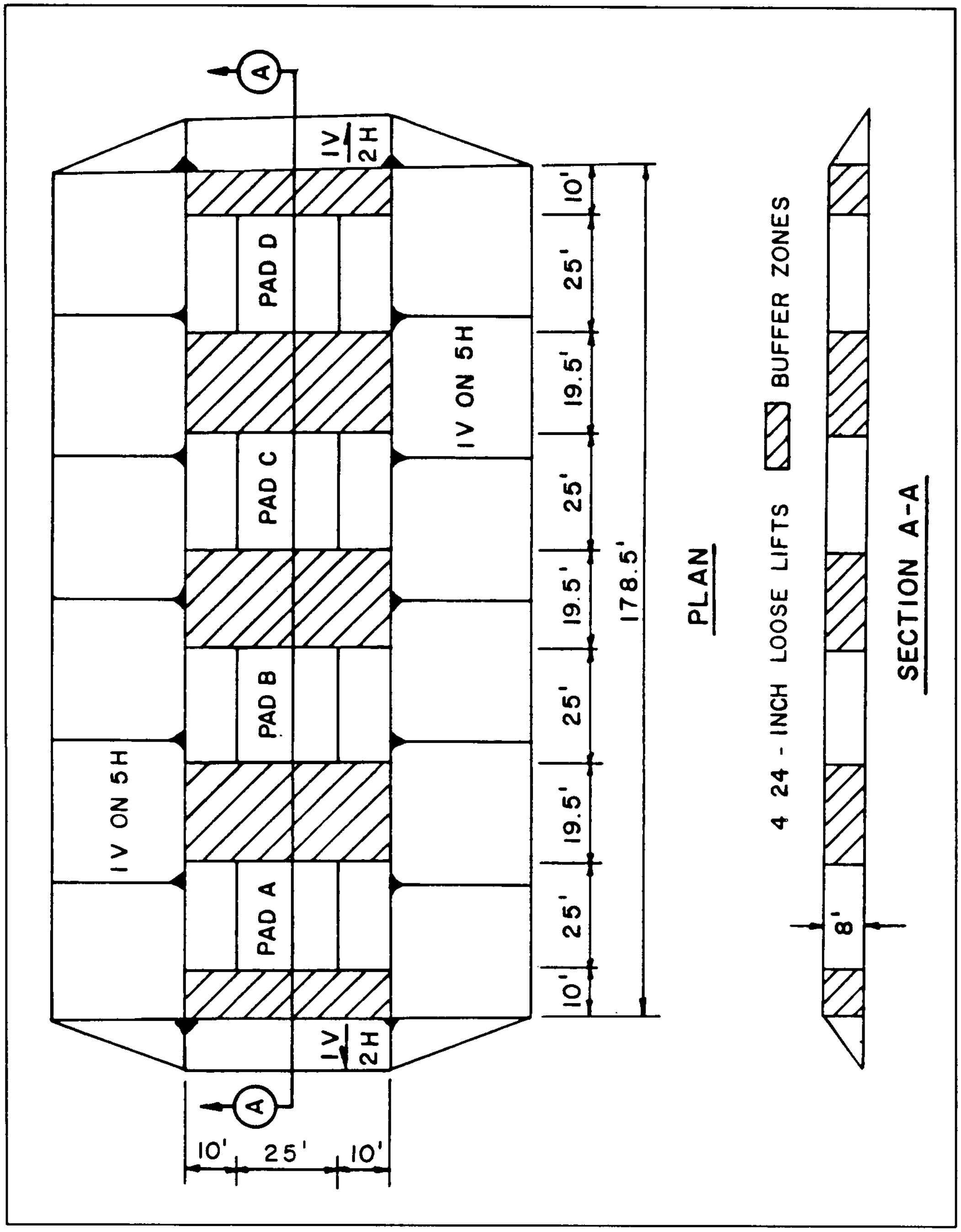
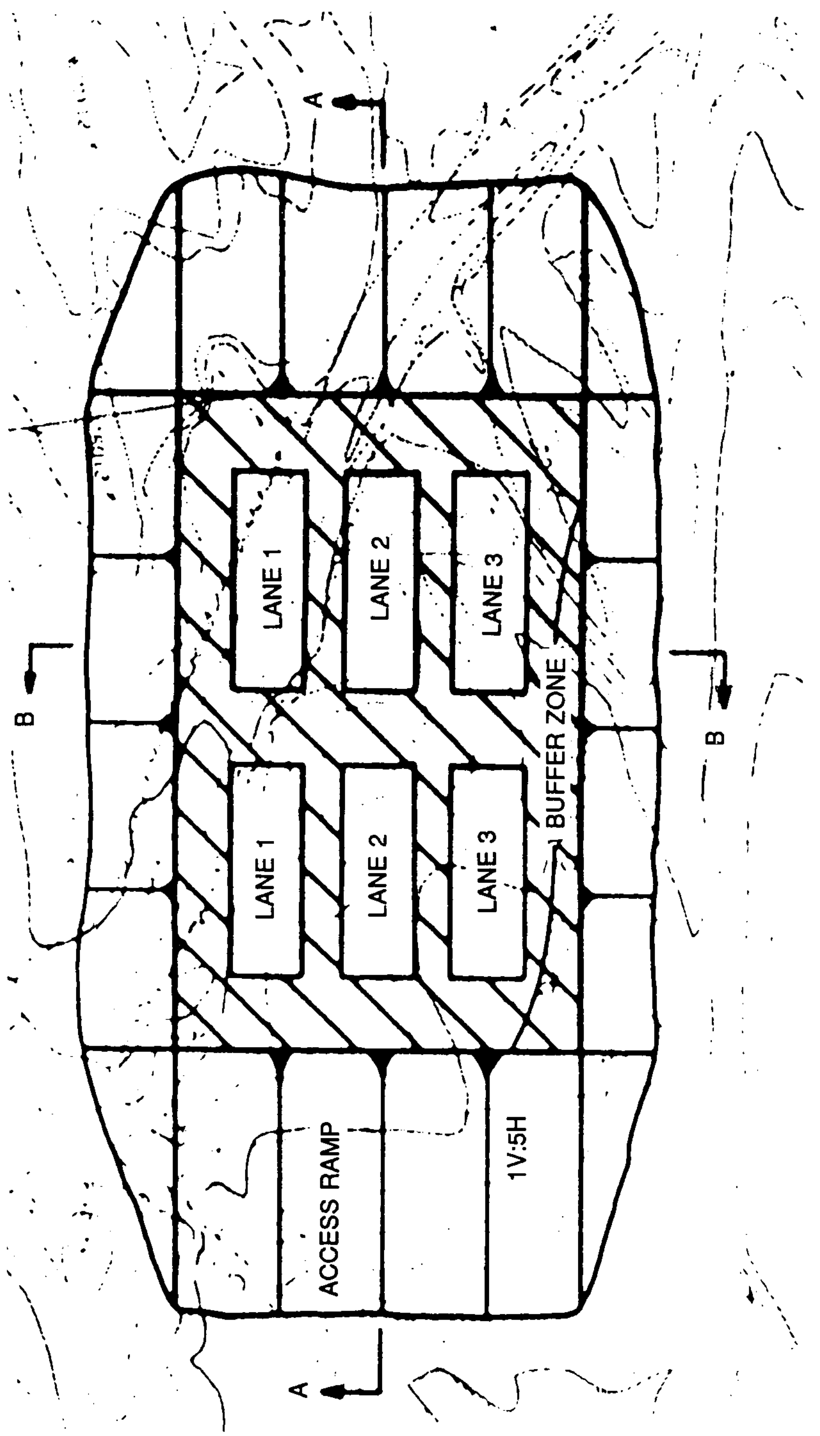
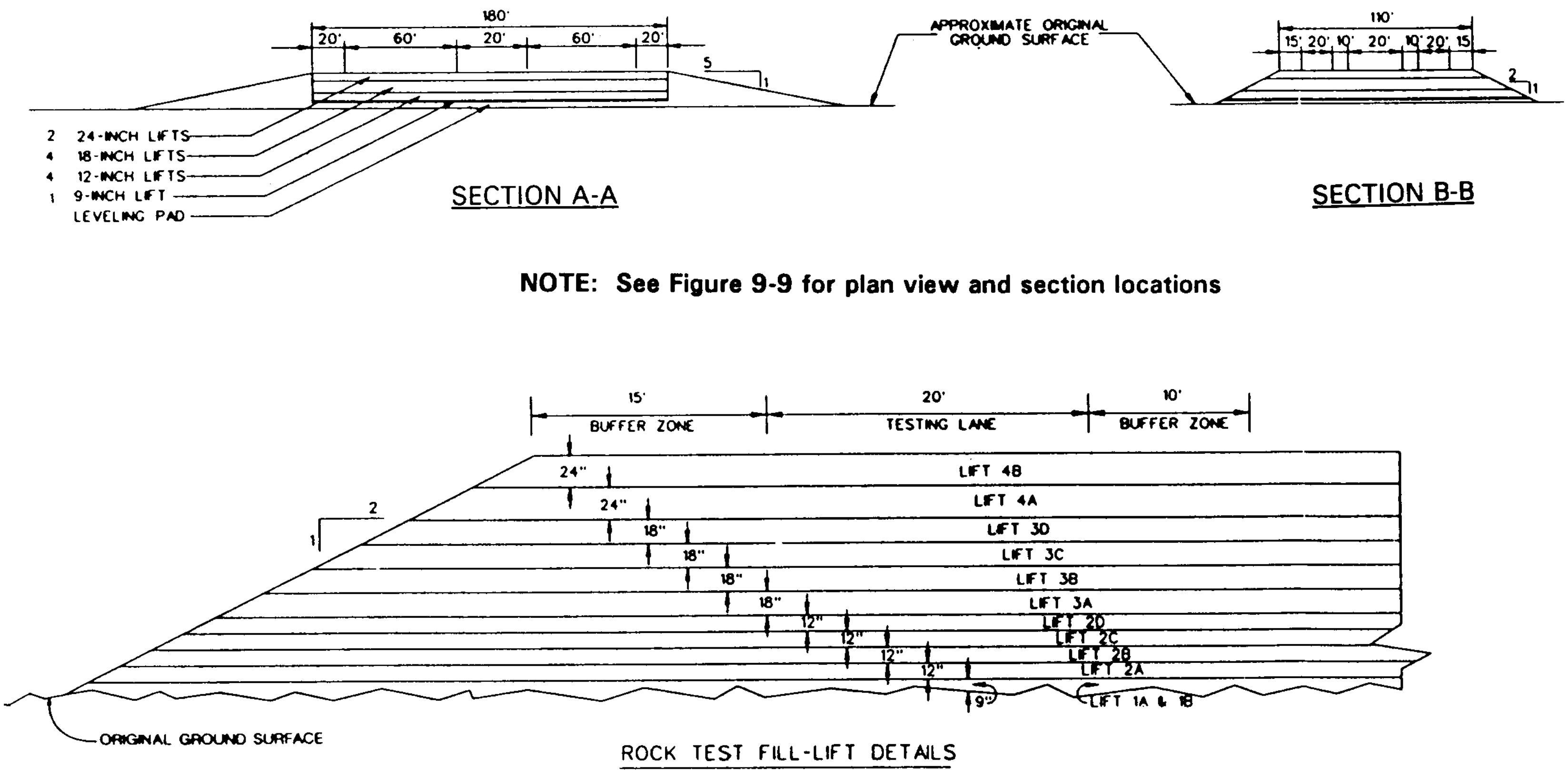


Figure 9-8. Cerillos Dam, plan and profile of test fill No. 3



NOTE: See Figure 9-10 for sections A-A and B-B

Figure 9-9. Seven Oaks Dam, plan view of the test fill



NOTE: See Figure 9-9 for plan view and section locations

Figure 9-10. Seven Oaks Dam, profiles of the test fill